

Chapter 3

SUPPORT FROM THE RESEARCH DIRECTORATES

Introduction

Between 1960 and 1975, the number of U.S. community colleges increased 250%, with an average of one new campus opening every week. As a result, credit enrollment at two-year colleges has increased at nearly triple the rate of that at baccalaureate-granting institutions, so that now approximately half the nation's first time college freshmen attend two-year colleges. Moreover, two-year college attendance is higher among nontraditional students, students from low socioeconomic backgrounds, and students who are the first in their family to attend college. It is this population from which the nation's future technical workforce will increasingly be drawn. For these reasons, NSF has, for a number of years, developed programs to strengthen SMET education and training provided by two-year colleges. What follows is a discussion of some ways in which this is being accomplished through the research directorates.

Research Experiences for Undergraduates (REU)

In SMET disciplines, it is especially important that students be exposed early and in progressively greater depth to authentic, practical, problem-solving experiences. To do otherwise would ill prepare them for work in a knowledge-based economy where technical skills and strong reasoning ability are highly valued. The REU program is supported by all the Foundation's disciplinary research programs. It provides opportunities for undergraduate students to experience hands-on participation in research or related scholarly activities in areas of science, mathematics, and engineering.

Several REU awards were made directly to community colleges. Through the Directorate for Biological Sciences, Massachusetts Bay Community College is developing an innovative summer program which targets students from two-year colleges (Award No. 9731991). Students are being extensively trained in various techniques used in molecular biology and biotechnology research. Each student undertakes at least one summer research externship designed to provide preparation both for graduate school and for the workplace. Participating research institutions include the Marine Biological Laboratory, the Texas Medical Center, Woods Hole, and the Molecular Biology Institute. Georgia Perimeter College, formerly Dekalb Community College, cooperated with Georgia State University to extend opportunities for students to participate in geoscience research using the regional geology of Georgia (Award No. 9820699).

Other awards were made to four-year institutions to provide two-year college students with opportunities for research. At Occidental College, a chemistry professor provides eight Southern California community college students with such an experience during a ten-week summer program supported by NSF's Chemistry Division (Award No. 9820255). During the program, the two-year college students live on the Occidental College campus while they investigate the biophysics of phospholipids, analyze protein structure, synthesize novel organometallic compounds, and determine the reaction rates of human erythrocyte dimers. Participants publish their results on the Web and present them at campus and regional undergraduate research symposia.

At California State University, Los Angeles, another chemistry professor provides a similar experience to a dozen two-year college students drawn from the surrounding low socioeconomic East and South Central Los Angeles neighborhoods. These students are usually the first in their families with any postsecondary education. The Chemistry Division's REU program (Award No. 9731839) supports training of these stu-

dents to use nuclear magnetic resonance and laser spectroscopy in investigating the synthesis, structure, and chemical reactivity of important organic and inorganic compounds; study significant chemical reactions occurring in the atmosphere; determine the mode of action of enzymes in plant growth; and determine how hemoglobin functions in respiration. As a result of this experience, most of these students go on to earn baccalaureate and post-graduate degrees in chemistry or biology. Also at California State University, an associate professor of physics and astronomy has developed an REU project, funded by NSF's Astronomical Sciences Division (Award No. 9820546), which supports the participation of a half dozen Los Angeles two-year college students in a year-round program that provides them with observing time at the Table Mountain facility that the Jet Propulsion Laboratory (JPL) operates for NASA. Access to these telescopes and the research scientists who operate them would be highly unlikely without NSF and JPL support, which provides inner city students a chance to participate in discovery and experience the fascination of observing the universe.

These projects are typical of the way the REU program enhances SMET education at two-year colleges. Many of the approximately 500 REU Site projects conducted annually by the nation's baccalaureate-granting colleges and universities include two-year college students as participants, and many more REU Supplement projects provide additional funding to regular NSF research awards to support the participation of undergraduates, including two-year college students, in the research.

Research Sites for Educators in Chemistry (RSEC)

NSF supports innovative approaches to enhancing the undergraduate curriculum and sustaining the disciplinary currency of faculty who teach undergraduates at two-year institutions as well as baccalaureate-granting institutions. One example of this support is the RSEC program, which is jointly funded by the Office of Multidisciplinary Activities and the Chemistry Division of the Directorate for Mathematical and Physical Sciences. Project Emerald, conducted by a chemist at the University of New Mexico with support from the RSEC program, allows two-year college faculty and their students to work with research scientists at the university as well as at the nearby Los Alamos and Sandia national laboratories. A large proportion of baccalaureate students in New Mexico start their undergraduate education at the state's two year colleges and do not have the same access to the skills, practices, and ethics of modern research as their counterparts at campuses that award doctoral degrees. With the assistance of the RSEC program, access to these largely federally funded programs and facilities is being significantly broadened.

Research in Undergraduate Institutions (RUI)

The RUI program is part of NSF's effort to help assure a broad base for science and engineering research, and thereby enhance the scientific and technical training of students in undergraduate institutions. The specific objectives of the program are to (1) support high-quality research by faculty with active involvement of undergraduate students, (2) strengthen the research environment in academic departments that are oriented primarily toward undergraduate instruction, and (3) promote the integration of research and education at predominantly undergraduate institutions. Through the RUI program, NSF provides support for research and research instrumentation for investigators in non-doctoral departments in predominantly undergraduate institutions (including two-year colleges). For example, the Astronomy Division supported Bevill State Community College in Alabama to study spiral galaxies (Award No. 9902918). Analytic studies and computer simulations of the inner resonance rings are being carried out to understand the disk and halo properties of the galaxies. The Berks Campus of Pennsylvania State University, one of the two-year colleges in the Penn State system, was supported by the Division of Materials Research to research the symmetry classification of domain structures (Award No. 9722799). The work on crystallographic

tables enhances understanding of symmetry properties of crystal growth and magnetic domain walls. Paul Smith's College in New York used an RUI grant (Award No. 9808972) to conduct a high-resolution analysis of the diatoms preserved in Lake Victoria, East Africa. The results of the study contribute to an understanding the history of, and forcing mechanisms of, equatorial climates of the Holocene. This understanding helps put the climatic history of Lake Victoria into a global context.

Network Infrastructure (NI)

This program encouraged and facilitated scholarly communication and collaboration by providing data network access to researchers and educators, supercomputer centers, and information resources. In FY1997, the NI program supported 21 two-year colleges to gain direct Internet access; in FY1998, it similarly supported four two-year colleges. By FY1999, the program was phased out. Two-year colleges were also supported through larger grants under the CISE Institutional Infrastructure program. Other two-year colleges were supported through larger grants that help consortia of institutions gain access to the Internet.

For example, J. F. Drake Technical College in Alabama gained access to the Internet to allow students and faculty to access informational resources (Award No. 9729704). A project based at Utah Valley State College (Award No. 9613949) connected three Native American two-year colleges (Provo College in Utah, Northwest Indian College in Washington, and Fort Peck Community College in Montana) and one museum to the Internet. Palm Beach Community College in Florida used its NSF support to serve approximately 50,000 students in a wide range of academic programs that led to both associate degrees and transfer to four-year institutions (Award No. 9616884). Cambria County Community College in Pennsylvania, one of the nation's oldest trade and technical schools dedicated to the comprehensive rehabilitation of persons with disabilities, used its NSF funding to benefit its special population of students (Award No. 9710334).

Engineering Education and Centers (EEC)

The EEC Division seeks to stimulate new paradigms in engineering research and education that will accelerate technological and educational innovation and improve the quality and diversity of engineering graduates entering the technical workforce. To achieve its mission, the division facilitates integrated partnerships that cross disciplines and focus on technological systems. For example, academe is linked with industry and the states, and diverse academic institutions are joined in curricular and educational innovations. The objective is to yield well-rounded, professionally oriented engineers with a global outlook and the ability to assume leadership roles in industry, academe, and society. For example, a project at SUNY Farmingdale (Award No. 9727876) was established to assist the region's defense manufacturing companies in developing dual-use technologies, so that those companies could diversify into commercial markets. This award continues work originally made possible through the Technology Reinvestment Project and helps the Regional Center for Workforce Education transition to self-sufficiency and enables it to provide bridge support to the small businesses involved.

Other Selected Examples

El Paso Community College in Texas received support in FY1997 under the Instrumentation and Instrument Development program to conduct a study of the environmental factors that affect virus survival in ground water and surface water and the structural changes associated with viral inactivation and reactivation (Award No. 9604760). The instrument also supports research on isolation and characteriza-

tion of microorganisms, the use of bacteria and peat moss in the design of electrodes specific to heavy metals, and the use of a liquid scintillation system to purify and analyze radioactively labeled proteins.

Several professors at two-year colleges are actively involved in research projects. A PI at Honolulu Community College, supported through the Integrative Systems Program in Engineering and Computer Science (Award No. 9625557), studied models in noisy and changing environments. The research analyzed the behavior of supervised learning algorithms but focused on more complex reinforcement learning algorithms, including sequential detection problems and networking problems. A professor at Portland Community College in Oregon is participating in a study led by Oregon Graduate Institute of Science and Technology to determine, characterize, and model a new mechanism for solidification cracking observed in high purity iron-base alloys (Award No. 9972052). The Metals Program in NSF's Division of Materials Research is supporting this project. At New Mexico State University, Carlsbad Branch, a professor is taking an active leadership role in a study of the sulfur chemistry in the Antarctic atmosphere, including two summer field trips to the South Pole (Award No. 9809164). This study, which is supported through the Antarctic Oceans and Climate Systems program, is improving the understanding of oxidation chemistry of biogenic sulfur in the polar environment and the climatic interpretation of sulfur-based signals in Antarctic ice cores. In a project led by the University of California, Santa Barbara (Award No. 9818545), a professor at Bowling Green State University Firelands College in Ohio is working with others to address the effects of route comprehension on spatial knowledge acquisition. This study is being conducted to identify effective strategies of spatial learning that can contribute to the mobility and quality of life of visually impaired persons.

Other projects have a large effect on two-year colleges by involving two-year college faculty in professional development activities. For example, the Ultraviolet Impacts Network project (Award No. 9907674), led by the University of Nevada Desert Research Institute, is establishing a geosciences education network of two-year college faculty and students. The project aims to improve instruction in the physical concepts and processes that control ozone depletion and the resulting influences on ultraviolet climatology and health risk. This project is supported through the Geosciences Directorate's Awards to Facilitate Geoscience Education.